

- 10 the pickling is carried out in a pickling bath having a redox potential;  
11 the pickling solution comprises sulfuric acid and iron(III) sulfate;  
12 the spent pickling solution comprises dissolved copper;  
13 the spent pickling solution is regenerated by cathodically precipitating the  
14 dissolved copper and anodically regenerating the iron (III) sulfate.

1 17. (newly presented) The method of claim 16 in which the pickling  
2 solution additionally comprises a peroxodisulfate.

1 18. (newly presented) The method of claim 16 in which the pickling  
2 solution comprises 0.1 to 6 moles/L of sulfuric acid, 0.1 to 5 moles/L of copper  
3 sulfate, 0.1 to 1 moles/L of iron sulfates, and 0 to 2 moles/L of other sulfates.

1 19. (newly presented) The method of claim 18 in which the pickling  
2 solution additionally comprises a peroxodisulfate.

1 20. (newly presented) The method of claim 16 in which:

2 the regenerated pickling solution comprises iron(III) sulfate and a  
3 peroxydisulfate;

4 the redox potential of the pickling bath, measured against a silver/silver  
5 chloride reference electrode, is between 300 to 1150 mV ; and

6 the redox potential of the pickling bath is adapted to the requirements of  
7 the material being pickled by metering in the regenerated pickling solution.

1 21. (newly presented) The method of claim 16 in which:

2 the spent pickling solution comprises iron (III) sulfate and a  
3 peroxydisulfate;

4 a partial flow of the spent pickling solution is metered to a peroxodisulfate  
5 electrolytic cell that is partitioned into cathode spaces and anode spaces by ion  
6 exchange membranes:

7 the spent pickling solution first passes through the cathode spaces,  
8 whereby the iron(III) sulfate is reduced producing reduced iron(III) sulfate and the  
9 dissolved copper is precipitated as metallic copper; and

10 the spent pickling solution then passes through the anode spaces,  
11 whereby the reduced iron(III) sulfate is oxidized to iron(III) sulfate.

1 22. (newly presented) The method of claim 21 in which the spent pickling  
2 solution is enriched in peroxodisulfate in the anode spaces.

1 23. (newly presented) The method of claim 21 or claim 22 in which the  
2 metallic copper is separated from the peroxodisulfate electrolytic cell in powder  
3 form.

1 24. (newly presented) The method of claim 16 in which:  
2 the spend pickling solution comprises iron (III) sulfate, and  
3 the spent pickling solution passes through a metal-recovery electrolytic  
4 cell partitioned by ion exchange membranes or diaphragms whereby the  
5 dissolved copper is cathodically precipitated in compact form and recovered, the  
6 iron (III) sulfate is cathodically reduced, and the iron (III) sulfate is anodically  
7 regenerated.

1 25. (newly presented) The method of claim 16 in which:  
2 the spend pickling solution comprises iron (III) sulfate,  
3 metallic copper in powder form is added to the spent pickling solution from  
4 the pickling bath whereby the spent pickling solution is freed of iron(III) sulfate;  
5 the spent pickling solution passes through a metal-recovery electrolytic  
6 cell partitioned by ion exchange membranes or diaphragms whereby the  
7 dissolved copper is cathodically precipitated in compact form and recovered, and  
8 the iron (III) sulfate is anodically regenerated;

9 a partial flow of the spent pickling solution is metered to a peroxodisulfate  
10 electrolytic cell that is partitioned into cathode spaces and anode spaces by ion  
11 exchange membranes;

12 the spent pickling solution first passes through the cathode spaces of the  
13 peroxodisulfate electrolytic cell, whereby the iron(III) sulfate is reduced producing  
14 reduced iron(III) sulfate, and the dissolved copper is precipitated to form the  
15 metallic copper in powder form, which is separated from the peroxodisulfate  
16 electrolytic cell and added to the spent pickling solution from the pickling bath;

17 the spent pickling solution then passes through the anode spaces of the  
18 peroxodisulfate electrolytic cell, whereby the reduced iron(III) sulfate is oxidized  
19 to iron(III) sulfate and the regenerated pickling solution is produced;

20 the redox potential of the pickling bath, measured against a silver/silver  
21 chloride reference electrode, is between 300 to 1150 mV ; and

22 the redox potential is adapted to the requirements of the material being  
23 pickled by metering in the regenerated pickling solution.

1 26. (newly presented) The method of claim 25 in which the pickling  
2 solution additionally comprises a peroxodisulfate.

1 27. (newly presented) The method of claim 16 in which:

2 the spend pickling solution comprises iron (III) sulfate,

3 the spent pickling solution passes through a metal-recovery electrolytic  
4 cell partitioned into cathode spaces and anode spaces by ion exchange  
5 membranes or diaphragms whereby the dissolved copper is cathodically  
6 precipitated in compact form and recovered, and the iron (III) sulfate is anodically  
7 regenerated;

8 a partial flow of the spent pickling solution is metered to a peroxodisulfate  
9 electrolytic cell that is partitioned into cathode spaces and anode spaces by ion  
10 exchange membranes;

11 the spent pickling solution first passes through the cathode spaces of the  
12 peroxodisulfate electrolytic cell, whereby the iron(III) sulfate is reduced producing  
13 reduced iron(III) sulfate and the dissolved copper is precipitated as the metallic  
14 copper in powder form, which is separated from the peroxodisulfate electrolytic  
15 cell;

16 the spent pickling solution then passes through the anode spaces of the  
17 peroxodisulfate electrolytic cell, whereby the reduced iron(III) sulfate is oxidized  
18 to iron(III) sulfate, whereby the regenerated pickling solution is produced; and

19 a partial flow of spent pickling solution passes through the anode spaces  
20 of the metal-recovery electrolytic cell to the pickling bath is greater than a partial  
21 flow of spent electrolyte passing through the cathode-spaces of the metal-  
22 recovery cell, the cathode spaces of the peroxodisulfate electrolytic, and the  
23 anode spaces of the peroxydisulfate cell to the pickling bath.

1 28. (newly presented) The method of claim 16 in which:

2 the spent pickling solution passes through a metal-recovery electrolytic  
3 cell partitioned into cathode spaces and anode spaces by ion exchange  
4 membranes or diaphragms whereby the dissolved copper is cathodically  
5 precipitated in compact form and recovered, and the iron (III) sulfate is anodically  
6 regenerated; and

7 the pickling solution comprises a peroxodisulfate; and

8 the concentration of the peroxodisulfate is increased to 0.1 to 1.0 moles/L  
9 in the metal-recovery electrolytic cell and the resulting solution is immediately  
10 stored in order to increase for a short time the redox potential from a lower level  
11 to a predetermined higher level by metering this solution into the pickling bath.

1 29. (newly presented) The method of claim 20, 25, 26, 27, or 28 in which  
2 the pickling solution comprises 0.1 to 6 moles/L of sulfuric acid, 0.1 to 5 moles/L  
3 of copper sulfate, 0.1 to 1 moles/L of iron sulfates, and 0 to 2 moles/L of other  
4 sulfates.

1 30. (newly presented) The method of claim 16, 17, 26, 27 or 28 in which:

2 the copper or copper alloy is selected from the group consisting of copper,  
3 brass, bronzes, and alloys of copper comprising small amounts of one or more  
4 elements selected from the group consisting of nickel, cobalt, iron, lead,  
5 beryllium, phosphorus, silicon, and zirconium; and

6 the redox potential, measured against a silver/silver chloride reference  
7 electrode, is between 500 and 700 mV.

1 31. (newly presented) The method claim 16, 17, 26, 27 or 28 in which:  
2 the copper or copper alloy is a copper-nickel alloy comprising more than  
3 10% nickel; and

4 the redox potential, measured against a silver/silver chloride reference  
5 electrode, is between 700 and 1150 mV.

1 32. (newly presented) The method claim 16, 17, 26, 27 or 28 in which:  
2 the copper or copper alloy is a copper alloy with tellurium or sulfur; and  
3 the redox potential, measured against a silver/silver chloride reference  
4 electrode, is between 300 and 500 mV.

1 33. (newly presented) The method of claim 16 in which the pickling  
2 solution additionally comprises one or more additives selected from the group  
3 consisting of activators, inhibitors, and complexing agents.

The Examiner is invited to phone applicants' attorney if it is believed that a telephonic or personal interview would expedite prosecution of this application.